Journal of
Vascular Diseases

MDPI

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Superficial Temporal Artery: Anatomical Variation and Its Clinical Significance

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Abstract: Background: The superficial temporal artery (STA) typically bifurcates into frontal and parietal branches in the temporal region. This study describes a rare anatomical variation identified during a cadaveric dissection where the STA presented an early cervical bifurcation. Methods: A cadaveric dissection was performed on a 58-year-old Caucasian female specimen injected with synthetic polymers. The STA was meticulously dissected, and anatomical findings were documented through photographs and measurements. Results: An unusual cervical bifurcation of the STA was observed. The frontal and parietal branches originated at the level of the posterior belly of the digastric muscle, ascending separately. The anterior branch, identified as the frontal branch, coursed below the facial nerve and stylomastoid artery, reaching the temporal line without further branching after giving the transverse facial artery as the only collateral branch. The posterior parietal branch extended posteriorly to the external acoustic meatus, compensating for the absence of the posterior auricular artery. This anatomical variation might influence surgical approaches to the head and neck region, particularly in parotid and reconstructive surgeries. Discussion: Variations in STA anatomy can significantly impact clinical practices, including reconstructive surgery, vascular interventions, and esthetic procedures. Imaging techniques, though useful, may not detect such rare variants. Cadaveric dissection remains a crucial tool for detailed anatomical assessment. Conclusions: This study highlights the importance of recognizing the STA's vascular variations for safe surgical planning and improving patient outcomes. Further studies correlating imaging findings with cadaveric dissections are recommended.

Keywords: superficial temporal artery (STA); anatomical variation; cadaveric dissection; head and neck surgery; reconstructive surgery

Academic Editors: Ciro De Luca and Ralf Kolvenbach

Received: 26 January 2025
Revised: 12 March 2025
Accepted: 1 April 2025
Published: 3 April 2025

Citation: Fagni, N.; Valli, L.; Nittari, G.; Procelli, G.; Branca, J.J.V.; Cuomo, R.; Mandalà, M.; Bertelli, E.; Cotofana, S.; Paternostro, F. Superficial Temporal Artery: Anatomical Variation and Its Clinical Significance. *J. Vasc. Dis.* **2025**, *4*, 14. https://doi.org/10.3390/jvd4020014

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1. Introduction

The superficial temporal artery (STA) is one of the two terminal branches of the external carotid artery. It originates in the neck within the parotid gland, and then it ascends in front of the tragus, crossing the posterior root of the zygomatic process of the temporal bone. It follows a superficial course along the temporal region of the skull between the subcutaneous tissue and the superficial fascia of the SMAS (superficial musculo-aponeurotic system), which includes the auricular mimic muscles, before dividing into a frontal and a parietal branch. The distribution area of the STA includes the frontal, temporal, and parietal scalp, the parotid gland, the temporomandibular joint, the temporal muscle, and the external auditory canal. Its course maintains a close relationship with the auriculotemporal nerve, a branch of the mandibular nerve.

During its course, the STA gives rise to several branches, including the parotid branches, transverse facial artery, anterior auricular branches, zygomatico-orbital artery, middle temporal artery, and frontoparietal artery [1,2].

The anatomical variations in the STA, as documented by Bergman [3], include aberrant origins of various vessels such as the internal maxillary artery, the tympanic artery, and branches that generally arise from the facial artery [4]. In addition, cases of STA absence and variations in its terminal branches have been reported [5].

The anatomical relationship between the STA and other structures makes this artery highly significant in clinical contexts, such as reconstructive surgeries where the STA serves as a vascular pedicle or esthetic procedures where vascular complications can occur, making management challenging [6,7]. Though rare, anatomical variations in the STA are clinically significant as they can influence both the diagnosis and management of vascular conditions and surgical approaches to the temporal region and the temporomandibular joint.

A critical clinical aspect of the STA involves its use and preservation in reconstructive procedures involving temporoparietal, parieto-occipital, frontal, and preauricular flaps. These flaps are intended to cover various head defects. The knowledge of STA anatomical variants helps ensure an adequate blood supply to the flap, as confirmed by Mateusz Koziej et al. [8].

The current literature highlights that computed tomography angiography (CTA) is the preferred choice for preoperative imaging in facial reconstructive surgery, as it provides superior small vessel imaging compared to magnetic resonance angiography [9]. Furthermore, some studies have focused on vascular mapping, structural variations, and Doppler ultrasound assessments of the STA, even though ultrasound techniques are not specifically used to study the anatomical variations in the STA, and in this context, there are also powerful techniques to study STA anatomy [10–12]. Nevertheless, anatomical dissection is still the method of choice to study human body structures, including blood vessel variations. Indeed, though the real frequency of this phenomenon is not clear, it is known that the hemodynamic balance may sometimes exclude the angiographic visualization of blood vessels or anastomoses that become functionally operative only after blood flow perturbations occur [13,14]. Current knowledge of the STA course is also relevant in rheumatology, as a biopsy of its frontal branch is considered the standard diagnostic tool for giant cell arteritis [15,16].

Occasionally, the STA may be affected by silent aneurysms, which are rare vascular lesions. Clinically, they often present as scalp swelling following local trauma, commonly with a pulsatile hematoma at the site of the lesion [5,17].

The temporal region, vascularized by the frontal branch of the STA, is also of great esthetic interest since it is a common area for dermal filler injections [6]. Proper injection techniques and anatomical knowledge of the STA's frontal branch are essential to minimize filler complications, such as inflammatory nodules, tissue necrosis, hypersensitivity reactions, blindness, and cerebral ischemia [18].

Although anatomical variations in the STA have been noted, early cervical bifurcation specifically has not been explicitly mentioned elsewhere. This research sought to fill that void by recording a unique case noted during cadaver dissection.

The identification of anatomical STA variants and the description of their anatomical relationships should therefore be considered on a case-by-case basis, and individualized evaluations can thus optimize patient management approaches.

This study documents and reports an unusual anatomical variation in the STA characterized by its early bifurcation at the cervical level, observed during an anatomical dissection of an injected human cadaver specimen.

2. Materials and Methods

The observations in this case report were performed at the ICLO Teaching and Research Center (Verona, Italy), an authorized institution for cadaveric studies, in November 2024.

The dissection of a human Caucasian female cadaver aged 58 years, injected with synthetic resins (acrylic polymers) colored red for arteries and blue for veins, was performed for teaching purposes.

The dissection required careful identification of anatomical landmarks and meticulous handling of the artery and adjacent structures. The artery was located using key anatomical landmarks, and it originated below the external acoustic meatus and passed in front of the tragus crossing the zygomatic arch.

The dissection began with a surface marking in the preauricular region. A vertical incision approximately 4–5 cm long was made, starting anterior to the tragus and extending superiorly. Once the skin was incised, the subcutaneous tissue was carefully dissected using blunt dissection to avoid unnecessary trauma to the skin and to achieve a more precise dissection. The superficial fascia was exposed, and further dissection revealed the STA.

The STA lay superficial to the temporalis muscle and was accompanied by superficial temporal veins and the auriculotemporal nerve. The artery was carefully separated from the nerve to avoid causing nerve injury and loss of its anatomical relationships.

Dissection was achieved using the following standard surgical tools: scalpel, Metzenbaum scissors, iris scissors, anatomical forceps, surgical forceps, and DeBakey forceps.

Once the STA had been identified and isolated anterior to the tragus, the course of the artery was followed distally and proximally to reveal its origin and branching pattern. The auricle was initially preserved for anatomical orientation (Figure 1) and then removed for better visualization (Figure 2).

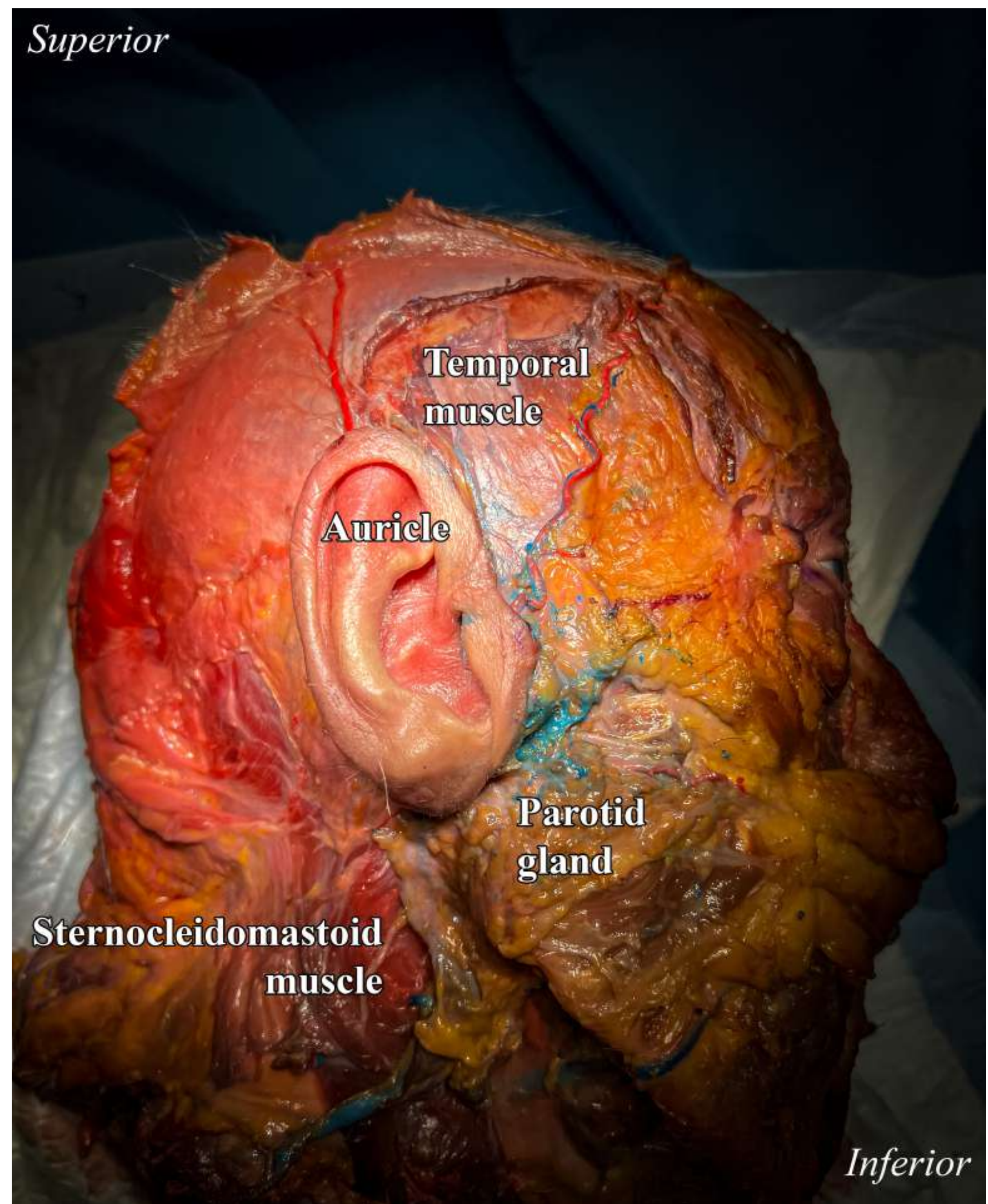

Figure 1. Dissection of superficial layers with auricular pavilion in place. Lateral view of anatomical preparation. Temporal, infra-temporal, and parotid regions.

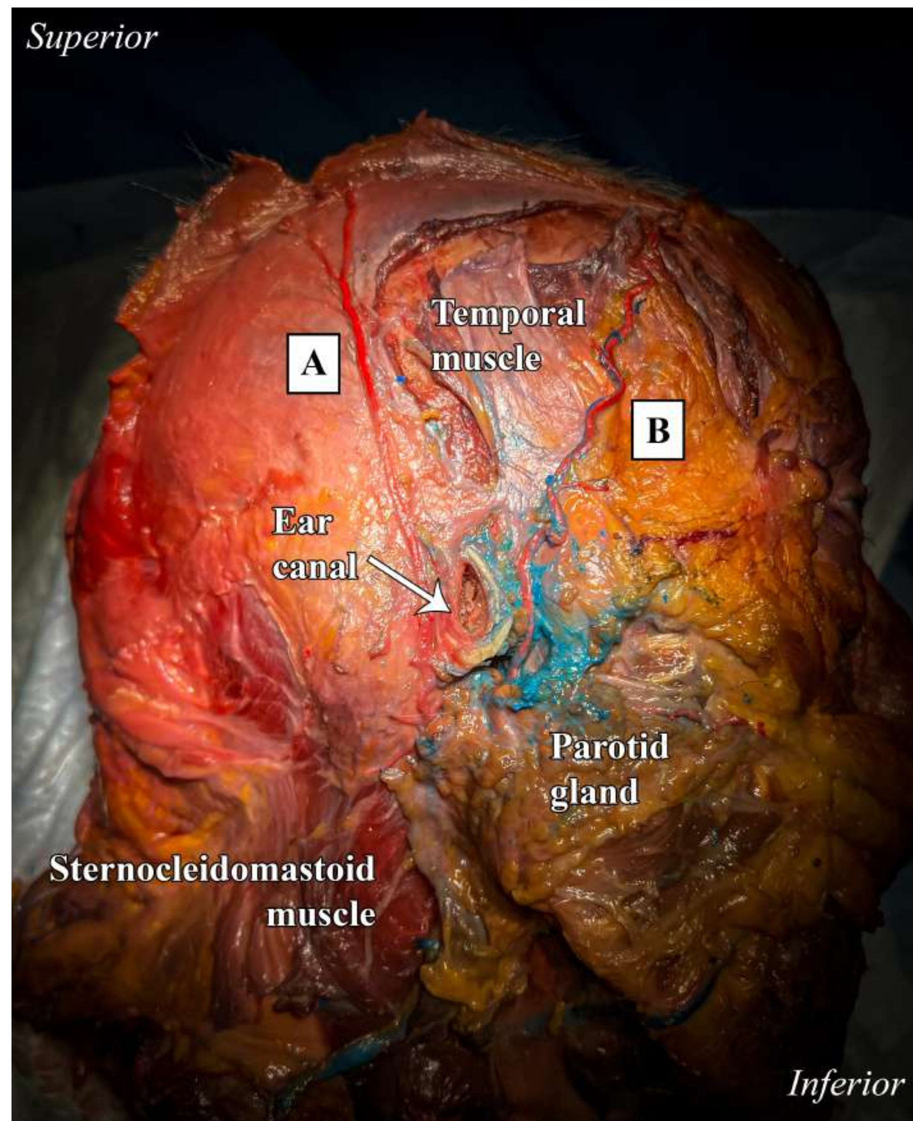

Figure 2. Dissection of superficial layers without auricular pavilion. Lateral view of anatomical preparation: temporal, infra-temporal, and parotid regions. Posterior parietal branch (A) and anterior frontal branch (B).

3. Results

During the dissection classes, professors and technicians identified a notable variant of the STA and recognized the importance of highlighting this finding. The dissection class was specifically designed to examine the parotid gland for the education of medical students: indeed, the blue staining observed was due to the dye used to enhance the visibility of the parotid gland. After discovering the variant of the STA, the auricular region was removed to better illustrate the anatomical course of this variant artery.

Under normal conditions, the STA divides into its terminal branches in the temporal region [12,19]. In the presented case, however, the frontal and parietal branches originated atypically at the cervical level and ascended separately towards the parietal and frontal regions.

The anterior branch, identified as the frontal branch, followed an anterior course to the external auditory canal, while the posterior branch, identified as the parietal branch, ascended posteriorly. Their origin was approximately 4 cm below the lower margin of the external auditory canal cartilage, close to the lower border of the posterior belly of the digastric muscle. During its course, the anterior branch traversed the parapharyngeal space beneath the plane of the facial nerve and the stylomastoid artery (Figure 3). In this case, the relationship between the STA and the facial nerve highlights the importance of performing careful anatomical identification to prevent nerve injuries during surgical procedures.

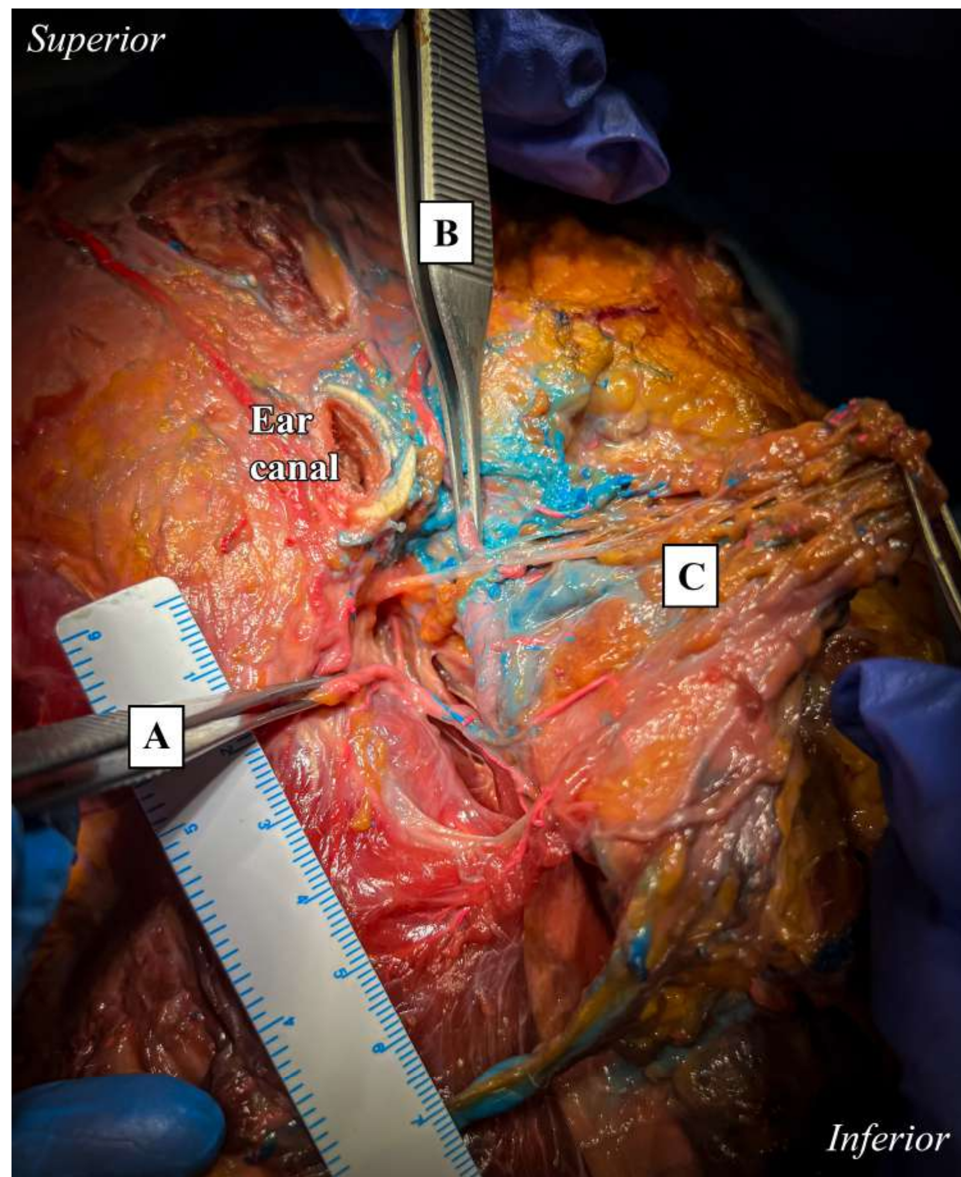

Figure 3. Lateral view of the anatomical preparation of the infra-temporal and parotid regions. Emergence of anterior (middle clamp, B) and posterior (left clamp, A) terminal branches. Measurement of the distance from the inferior margin of the external auditory canal section of the emergence. Course of the anterior branch below the plane of the VII N.C. (C, lifting of superficial parotid). A ruler was used as the scale bar, providing an accurate reference for proportional measurements.

The anterior branch continued its course without further bifurcations, reaching the temporal line with a length of approximately 10 cm (Figure 4). Notably, the transverse facial artery, which typically originates from the main trunk of the STA, was in this case a collateral branch of the anterior branch of the STA (Figure 5).

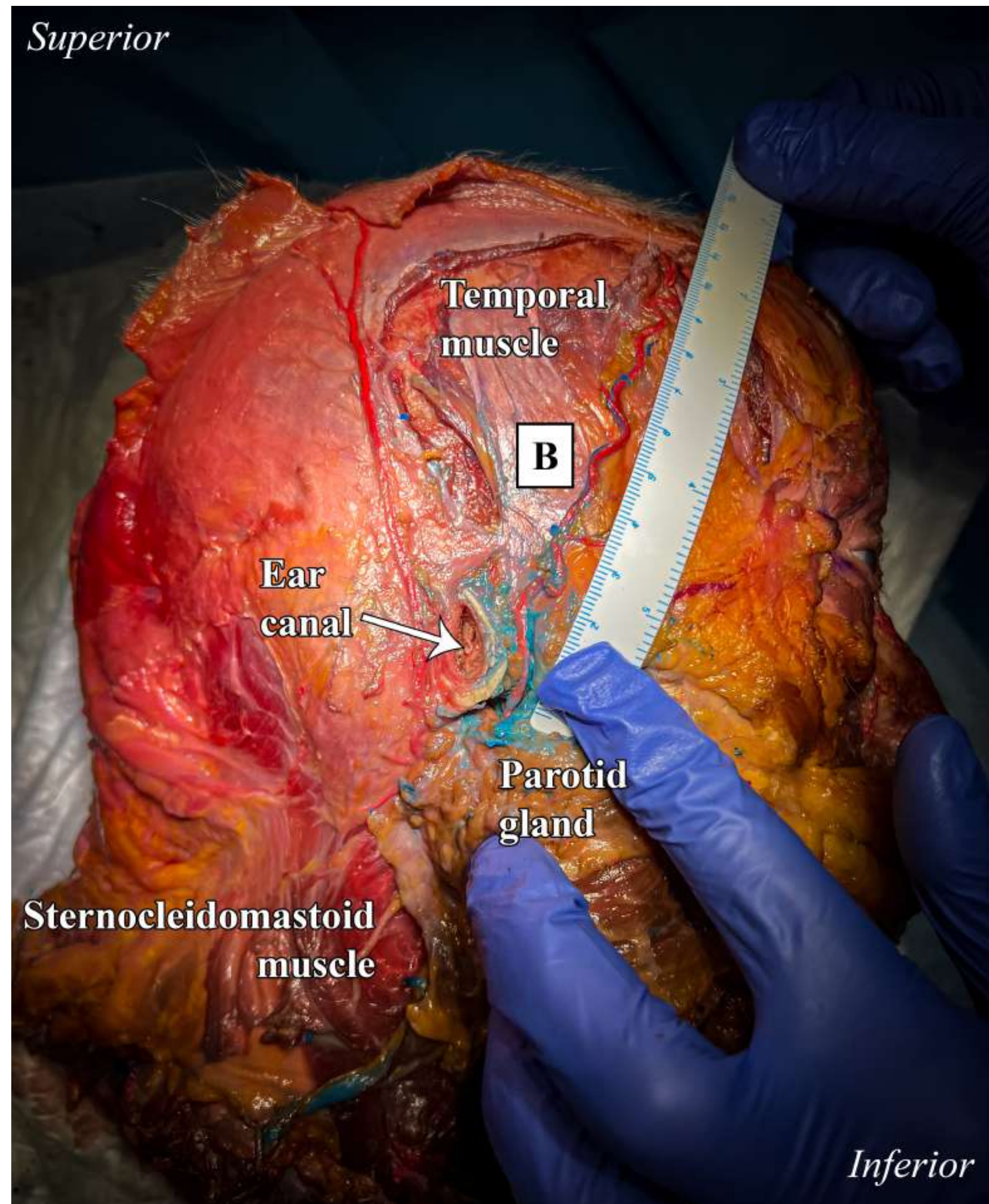

Figure 4. Lateral view of anatomical preparation: temporal, infra-temporal, and parotid regions. Frontal branch (B). A ruler was used as the scale bar, providing an accurate reference for proportional measurements.

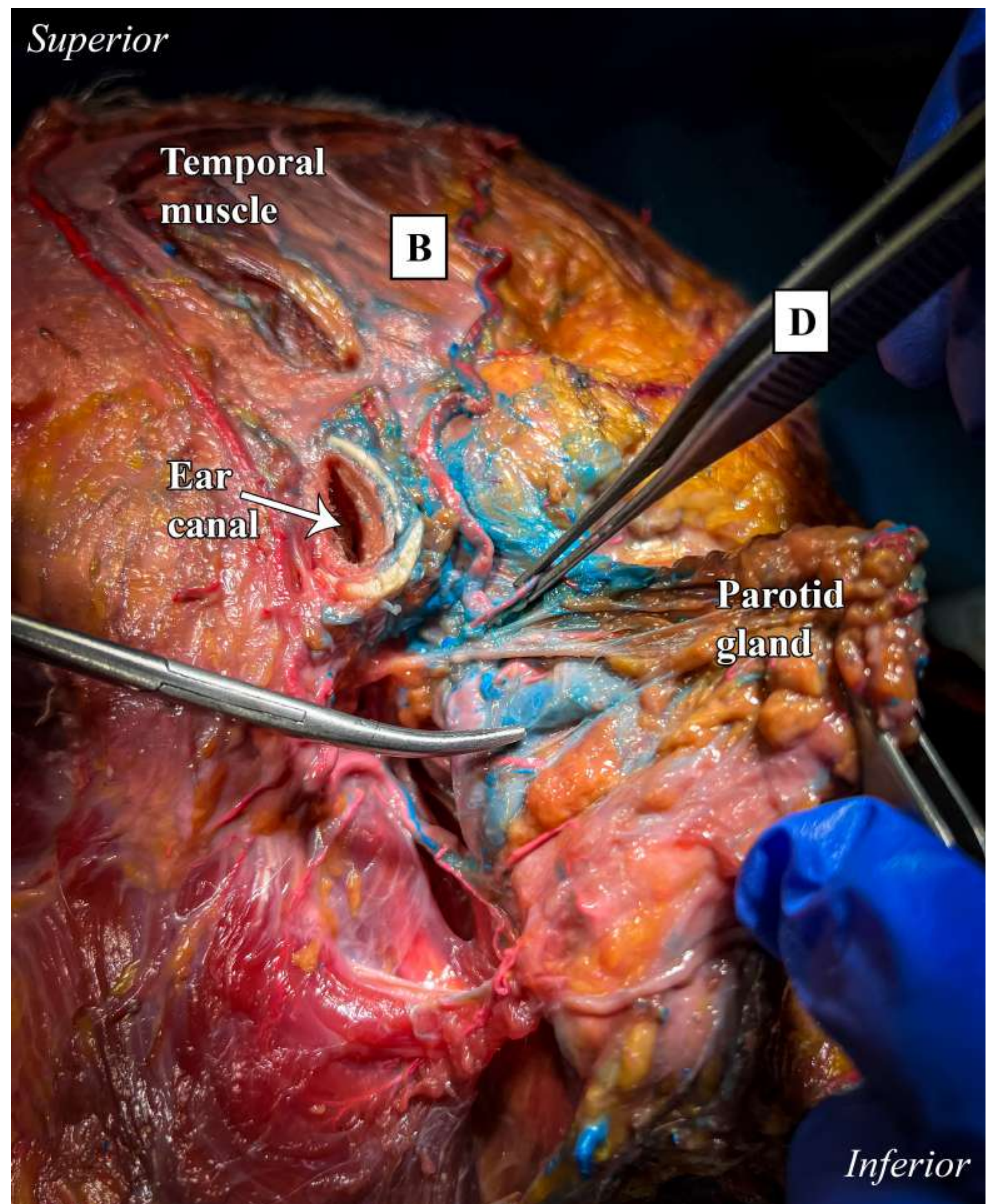

Figure 5. Lateral view of anatomical preparation: temporal, infra-temporal, and parotid regions. Transverse artery of the face (D) collateral to the frontal branch (B).

The posterior branch, corresponding to the parietal ramus, followed a course posterior to the external auditory canal; after that, it followed the galea aponeurotica above the mastoid region, extending superiorly and posteriorly. It covered a region typically supplied by the posterior auricular artery, with a measured length of approximately 13 cm (Figure 6).

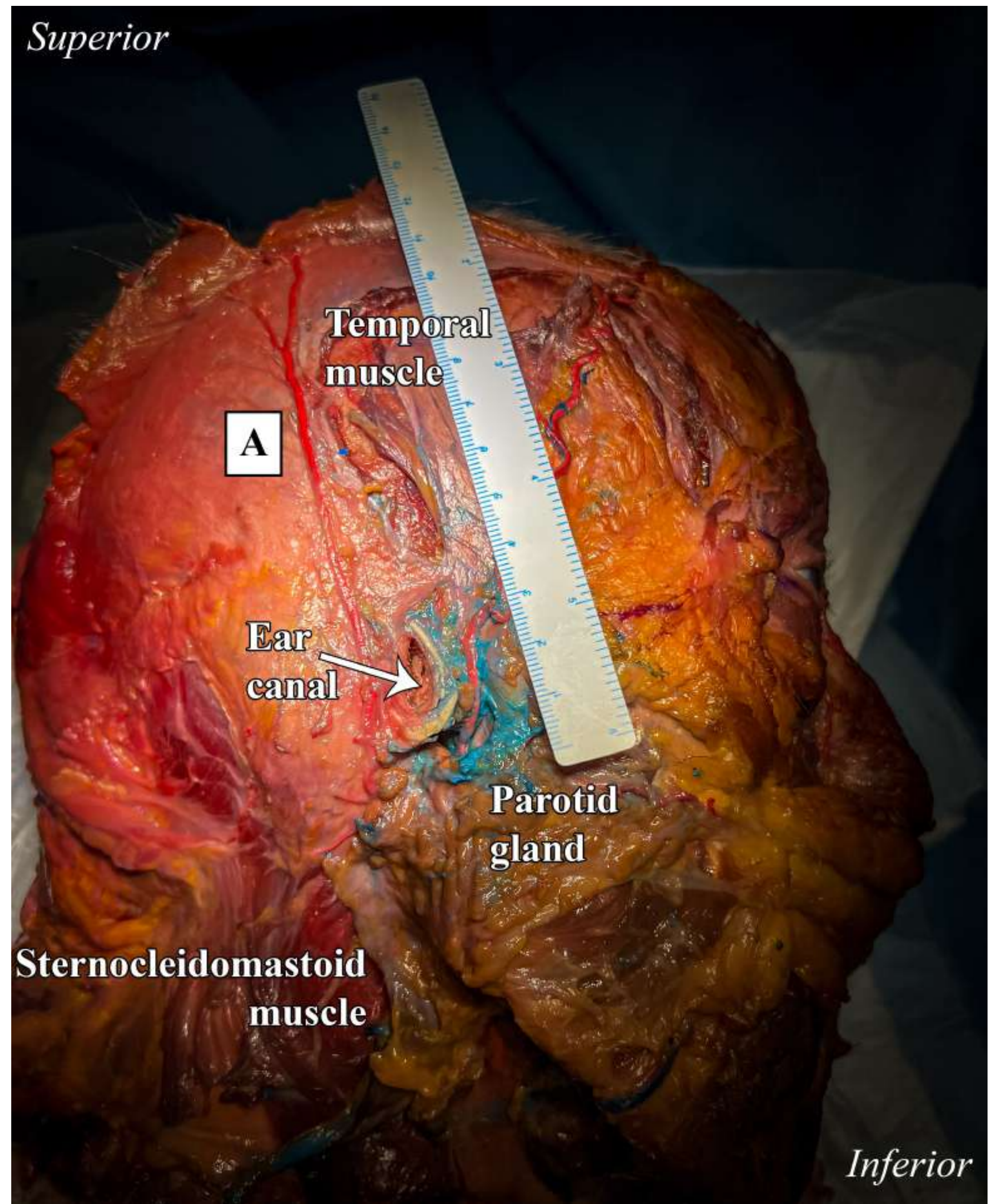

Figure 6. Lateral view of anatomical preparation: temporal, infra-temporal, and parotid regions. Parietal branch (A). A ruler was used as the scale bar, providing an accurate reference for proportional measurements.

4. Discussion

The superficial temporal artery (STA) is a critical anatomical structure in the head and neck region, and its variations can have profound implications for clinical practice. In this study, we identified a rare anatomical variant of the STA that differs from the typical bifurcation pattern reported in regular textbooks, characterized by its early bifurcation at the cervical level (Figure 7). This finding underscores the importance of recognizing anatomical variations that may influence surgical approaches, diagnostic procedures, and therapeutic interventions in the temporal region.

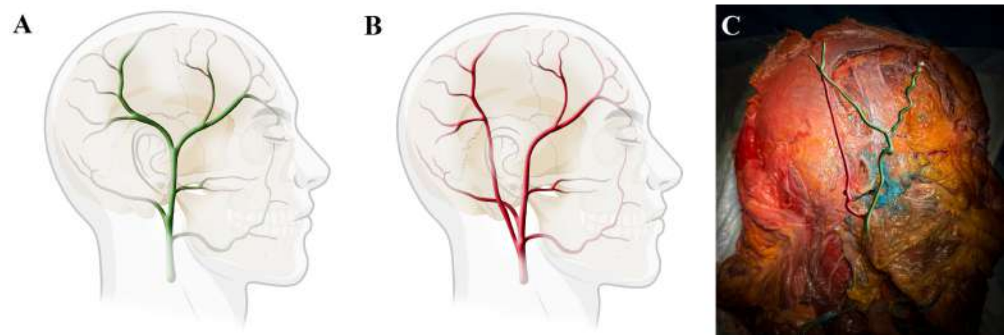

Figure 7. Graphical representation of the STA. The "normal" anatomical course of the STA (**A**), the observed STA variant (**B**), and the superimposed courses of the "normal" (green) and "variant" (red) STA as visualized in the anatomical preparation (**C**). Created and modified using Biorender.com.

The topography of the STA is bilaterally symmetrical in 65% of cases, with a retrocondylar course. Its bifurcation is usually at the level of the posterior zygomatic root or slightly above. The bilateral presentation of both terminal branches is seen in 80% of cases. However, some cases report absent or hypoplastic parietal branches (16% unilaterally, 9% bilaterally) and frontal branches (4%). Another study found the STA bifurcated on average 31.7 mm from the zygoma, with 8% showing no bifurcation [5,7,20]. These variations are critical in surgery, particularly in neurosurgical and vascular procedures, emphasizing the need for preoperative imaging.

Our case demonstrated that both branches exhibited an atypical cervical bifurcation. The absence of the posterior auricular artery was also compensated for by the posterior parietal branch of the STA, which had an early bifurcation 4 cm from the external carotid artery. The transverse facial artery is the only branch of the anterior frontal branch of the STA.

The STA is pivotal in reconstructive surgeries, serving as a blood supply for flaps like the temporoparietal, parieto-occipital, frontal, and preauricular flaps. Anatomical variations, such as early cervical bifurcation, can influence flap viability and surgical outcomes.

Understanding such anatomical variations is crucial in head and neck surgery, particularly for the parotid gland and facial nerve. A cervical bifurcation may complicate parotidectomies, and the relationships between the STA and the facial nerve highlight the need for precise identification to avoid injury. Furthermore, surgeons performing facelift procedures or temporal artery biopsies should be aware of such variations to reduce risks including nerve damage and excessive bleeding. Although cadaver specimens can be used to detect such variations in STA, some limitations of cadavers include the preservation of viable tissues, postmortem changes, limited samples, and ethical regulations. An adequate understanding of cadaver examination and imaging techniques is thus often necessary.

The STA is a significant structure in esthetic medicine, particularly in facial filler injections in the temporal region. The frontal branch of the STA is often at risk during dermal filler procedures, and anatomical variations, such as the one observed in this study, may increase the risk of complications, including vascular occlusion, tissue necrosis, and even blindness due to an inadvertent intravascular injection. This highlights the importance of pre-procedure vascular mapping and imaging techniques to identify individual anatomical differences [21]. In this context, ultrasound-guided procedures may provide additional safety by facilitating the real-time visualization of vascular structures.

Anatomical variations also carry implications for interventional radiology. In cases where embolization or vascular occlusion is required, understanding the STA's precise course and branching pattern is critical to avoid complications. Inaccurate knowledge

of vascular anatomy can lead to incomplete embolization or inadvertent damage to adjacent structures [12,19].

Computed tomography angiography (CTA) remains the gold standard for preoperative vascular imaging in facial reconstructive surgery. However, the case presented here reinforces the irreplaceable value of cadaveric dissection in anatomical research and clinical education. Despite advancements in imaging technologies, cadaveric dissection provides unmatched insights into anatomical details, particularly in cases of rare or atypical variations.

5. Conclusions

This study highlights the necessity of cadaveric dissection in anatomical research to enhance imaging techniques for a more accurate understanding of anatomy. Given the decline in expertise related to cadaveric dissection, it is crucial for clinicians working in these anatomical regions to engage in further research on vascular anatomical variants.

Future studies should employ computed tomography angiography (CTA) to assess the prevalence of this variation in living patients, which can aid in improved surgical planning. Imaging should be considered prior to surgery in high-risk cases. Moreover, surgeons should actively look for these variations during procedures involving nearby structures, such as parotidectomies or cosmetic surgeries, to help prevent arterial damage.

Author Contributions: Conceptualization, S.C., F.P. and N.F.; methodology, G.P. and F.P.; validation, E.B. and F.P.; investigation, G.P. and F.P.; writing—original draft preparation, L.V., R.C. and M.M.; supervision, N.F., J.J.V.B. and G.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the 322 study before their death.

Data Availability Statement: All data are available in the main text.

Acknowledgments: The authors sincerely thank those who donated their bodies to science: their contributions advance medical knowledge and education for future generations. Furthermore, the authors are extremely grateful to Andrea Caruso for taking the photos included in this article and to all the staff of the ICLO Teaching and Research Center, Via Evangelista Torricelli 15/A, Verona, in particular Riccardo Cominotti and Gianni Sereni.

Conflicts of Interest: The authors declare no conflicts of interest.

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